AGRICULTURAL ENGINEERING

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H. B. WALKER, President RAYMOND OLNEY, Secretary-Treasurer

Vol. 5 SEPTEMBER, 1924 No. 9

CONTENTS

EDITORIALS 195

AGRICULTURAL ENGINEERING—WHEN PAR IS DATUM 196
By P. S. Lovejoy

ECONOMICS OF THE CORN PICKER-HUSKER 199
By C. O. Aspenwall

AGRICULTURAL ENGINEERING FROM THE FARM EQUIPMENT MANUFACTURER'S VIEWPOINT 200
By H. J. Hirschheimer

POWER REQUIRED TO DRIVE FARM PUMPS 201
By J. S. Baker

RESEARCH METHODS IN AGRICULTURAL ENGINEERING 203
—Some Research Features of the Application of Electricity to Agriculture
By R. W. Trullinger

SURVEY OF AGRICULTURAL ENGINEERING PROGRESS 209

A. S. A. E. AND RELATED ENGINEERING ACTIVITIES 211

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The Object and Scope of A. S. A. E. Activities

THE American Society of Agricultural Engineers was organized in December, 1907, at the University of Wisconsin by a group of instructors in agricultural engineering from several state agricultural colleges, who felt the need of an organization for the exchange of ideas and otherwise to promote the advancement of agricultural engineering. The object of the Society, as defined by the Constitution, is "to promote the art and science of engineering as applied to agriculture, the principal means of which shall be the holding of meetings for the presentation and discussion of professional papers and social intercourse, and the general dissemination of information by the publication and distribution of its papers, discussions, etc."

The membership of the Society represents all phases of agricultural engineering, including the educational, professional, industrial, and commercial fields.

The scope of the Society's activities embraces both the technical and economic phases of the application of engineering to agriculture, and is comprehended in the following general headings:

(a) Farm Power and Operating Equipment—power, implements, machines, and related equipment.
(b) Farm Structures—buildings and other structures and related equipment.
(c) Farm Sanitation—water supply; sewage disposal; lighting, heating, and ventilating of farm buildings, and related equipment.
(d) Land Reclamation—drainage, irrigation, land clearing, etc., and related structures and equipment.
(e) Educational—teaching, extension, and research methods, etc., employed in the agricultural engineering field.

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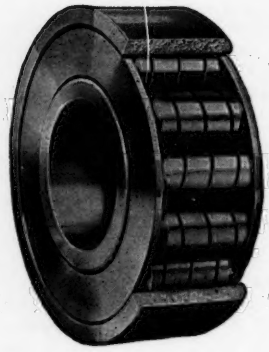

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AGRICULTURAL ENGINEERING

The Journal of Engineering as Applied to Agriculture

RAYMOND OLNEY, M. E., A. E., Editor

Vol. 5 SEPTEMBER, 1924 No. 9

EDITORIALS

THAT an engineered agriculture is one of the most fundamental necessities for putting agriculture on a more efficient and economic basis has long been recognized by the agricultural engineer. At the same time any agricultural engineer will readily admit that the field of possibilities in the application of engineering to agriculture has barely been scratched. It must also be admitted that only to a limited extent has the agricultural engineer been called upon or permitted to practice the science and art of real engineering in its application to agriculture. This is nothing more than what happened in the older branches of engineering in their earlier stages of development, but it is a fact the individual agricultural engineer must not lose sight of, that, sooner or later, the honest-to-goodness science, as well as the art, of engineering must and will be applied to agriculture on an extensive scale.

An Engineered Agriculture

Agricultural engineers will indeed appreciate the viewpoint so clearly and ably expressed by Mr. P. S. Lovejoy, in his article entitled "Agricultural Engineering—When Par is Datum," on another page of this issue, on the need of an engineered agricuture and the function of the agricultural engineer in supplying that need. Mr. Lovejoy points out that agriculture is in direct competition with the manufacturing industries and that the sufferings of agriculture today are in large part due to the fact that it is not and cannot compete—because it is not engineered.

While agricultural engineering has become established and recognized only in a limited degree compared with its ultimate possibilities, still it has reached a stage where agricultural engineers in various branches of the profession might well turn their attention to a well-organized, intensive effort to educate those, who need such education, of the economic needs of an engineered agriculture, what and how it should be engineered, and why they are adequately equipped and capable of undertaking the task on an extensive scale. The time is coming when the engineer must be turned loose in the agricultural industry as he has been in the manufacturing industries. And Mr. Lovejoy's discussion of an engineered agriculture, particularly as it relates to the Michigan Land-Economic Survey, will serve to impress the agricultural engineering profession even more forcibly than in the past of the tremendous task facing the agricultural engineer, and which it must be said he is eager to tackle.

"WHAT is an agricultural engineer?" The question was put by the manager of a 4200-acre farm. It was explained that, for example, an agricultural engineer could solve the problem of completely draining the farm he was managing. The manager had thought the farm was well drained, but this past wet season showed they had only gotten started. An agricultural engineer would have gone into the problem much deeper than this manager had done. The rainfall for years back would have been studied, the fall of the land would have been charted, parts of the farm now tiled would not have been tiled and other parts more completely tiled.

A Practical Answer

Men were observed shocking grain with pitchforks on this farm. An agricutural engineer would question that operation. Also manure is loaded on wagons by hand on this farm, but that will soon be a thing of the past because an agricultural engineer is building a manure loader for this purpose.

An agricultural-engineering problem was solved last year when the threshing time was reduced from one month to two weeks by setting a second thresher beside the first, eliminating two or three men. In the dairy barn practically twelve men were eliminated by the introduction of a milking machine. A book could be written about the economies that already have been effected by the introduction of labor-saving machinery on this farm.

This particular farm manager made the statement: "We have not scratched the surface here in comparison with what an agricultural engineer could accomplish. I wish I had one on this place now."

"What is an agricultural engineer?" This time the question was asked by the head of a company manufacturing oil cook stoves. The very thing that was worrying this official about the future extension of his business could be solved by an agricultural engineer. Such an engineer would make an investigation not only of the field in which these cook stoves are sold, but he would point out what is needed in the product to fit the users' requirements. The work which some of the agricultural-engineering departments of the state agricultural colleges are doing in household equipment studies is exactly the type of work the oil cook stove manufacturer wants.

Agricultural engineering is a new branch of engineering, yet its application is as old as civilization. Moreover, it is not confined to the fields of our six millions of farms, but is also found in the offices of our metropolitan sky-scrapers.

Recently we witnessed the demonstration of an entirely new machine for dusting cotton, potatoes, trees, and crops of all kinds. It was not developed by an agricultural engineer, but it will take one to perfect it. As a matter of fact, the company developing this machine will call on the agricultural-engineering department of a state university to assist in the testing. This decision came after an answer was received to the question: "What is an agricultural engineer?"

E. R. WIGGINS

AGRICULTURAL engineers, particularly those connected with the agricultural-engineering departments of the land grant colleges, have been frequently referred to as the farmers' "consulting engineers." It is a fact that they answer inquries from farmers by the tens of thousands each year—inquiries on all phases of engineering as applied to agriculture.

"Consulting Engineers"

There is a limit, of course, to the extent college agricultural engineers can go in helping farmers solve more or less complicated engineering problems. As a matter of fact, there is no reason why farmers should not expect to pay for professional engineering service the same as they have to pay for legal or other forms of professional service.

Before we have a real engineered agriculture—that is, engineered to an extent comparable to some of our manufacturing industries—the services of professional agricultural engineers must needs be employed on an extensive scale.

It should be obvious, therefore, that the responsibility of educating the agricultural industry to the employment of professional agricultural engineering service to a larger extent, and also the payment of equitable fees for such service, rests practically entirely on the shoulders of agricultural engineers.

Agricultural Engineering—When Par is Datum

By P. S. Lovejoy

Formerly in charge of the Michigan Land-Economic Survey

EDITOR'S NOTE: In this story of the Michigan Land-Economic Survey, Mr. Lovejoy has presented a new viewpoint of the field and function of the agricultural engineer—a viewpoint very much in harmony with the agricultural engineer's conception of his job, but perhaps not so convincing to the "old timers in the colleges," who have yet to acknowledge that engineering is the real basis of agricultural economics. Mr. Lovejoy takes the Michigan Land-Economic Survey as an example of where and how the agricultural engineer fits into the "new agriculture"—an agriculture put on a more efficient and economic basis by the unrestricted application of the science and art of engineering, and by giving the agricultural engineer free rein to develop a real engineered agriculture. Mr. Lovejoy's article is an inspiration, to say the least; at the same time it outlines the tremendous opportunity with its attendant problems awaiting the agricultural engineer.

THE Michigan Land-Economic Survey was created to do a job in agricultural engineering which no other agency seemed able or willing to undertake.

It is, I think, the location work on what will prove the first really comprehensive and competent effort at big-scale agricultural engineering ever undertaken in America.

Here I am using "agriculture" in its broader meaning; "The science and art of producing and utilizing plants and animals useful to man." And "engineering" is used in a corresponding sense: "The science and art of designing and contriving the procedure of construction to accomplish given ends in the most efficient manner."

That these are not the definitions usually associated with these words, and that the agricultural engineer, in the past, has usually been called upon and permitted to practice his science and art only in the accomplishment of odd and minor chores, such as ditching, blasting stumps or adjusting tractor hitches, digging marl and the like, is of no importance. If agricultural engineering is to reach the stature of its brother branches, the broader definition is correct and necessary.

It is high time, I think, that the agricultural engineer began to regard his profession as something vastly bigger than it has been to date, and that he should steadily insist, and demonstrate, that it is lack of proper engineering which has brought about the difficulties which now beset agriculture, and that until sound engineering is applied to agriculture, these troubles must continue.

The essence of all engineering is planned construction, and the essential for good planning or construction is dependable base data.

Before a good railroad grade may be built, there must be a good location survey, the running of precise levels; comparisons and calculations must be made; finally come the blueprints and specifications for grade, bridges, and the rest.

Before a big building or a big machine can be set, there must be inspection of the footings, delicate instrument work, detailed analysis and charting, definite anticipation of each successive step and operation and, finally, a precise and complete schedule of procedure—all worked out to accomplish the specific ends desired.

Through all our modern industrial world, engineering procedure is now a necessity and a matter of course. Industrial affairs are modern, in fact, only as they are engineered; and successful only as they are well engineered. From foundry foreman to sales manager and president, blueprints, graphs, and all manner of engineer's tools and practices are standard and everywhere.

But how is it in agriculture? There one must search to find even fragments of real engineering. The agricultural engineer has been used (when he has been used at all) rather like a handy-andy mechanic in a big manufacturing plant.

So long as we were a nation of farmers and farming was an art but not a science or an industry; so long as agriculture was a matter of pioneering and a mode of life rather than a business, there could be no competition between agriculture and industry. But now there is such competition.

Now agriculture is in direct competition with industry.

The engineering of agriculture, which means among other things the intelligent use of land, has a more important application in reclaiming the vast waste areas found in this country. It is largely the job of the agricultural engineer to get essential data on which any intelligent plan and program for the utilization of these lands must be based

"It is high time that the agricultural engineer began to regard his profession as something vastly bigger than it has been to date, and that he should steadily insist, and demonstrate, that it is lack of proper engineering which has brought about the difficulties that now beset agriculture, and that until sound engineering is applied to agriculture, these troubles must continue. . . . . Until agriculture is engineered it must continue to suffer, for it cannot escape competition with industry and cannot well compete with engineered industry until it, itself, is also and truly engineered."

Industry is well organized, staffed and operated by engineers—is engineered. But agriculture is not engineered.

Until agriculture is engineered it must continue to suffer, I think, for it cannot escape competition with industry and cannot well compete with an engineered industry until it, itself, is also and truly engineered.

The thing must be considered and worked from its very foundations, no doubt. The final footings of agriculture—including horticulture and forestry along with agronomy and animal husbandry in all its forms, of course—rest in the use of land (in the economist's sense of the word).

Agriculture, then, is really the science and art of using land for the production of plants and animals useful to man, and an engineered agriculture, fit and able to compete with an engineered industry, must list, study, and relate its raw materials, its extracting, manufacturing and selling operations, its transportation, power, labor and markets, etc., exactly as in the case of the other industries. In due season the intimate details of each item of agricultural procedure will be studied, analyzed and perfected (or junked) as fast as better ways and means can be devised.

So far our technical agriculturists have been in charge and the experiment stations have been setting the pace. They have been concerned with intimate details of silos and alfalfa, soil amendments and breeding stocks, diseases and pests—and have been incompetent and unwilling to consider or deal with the fundamentals. They have been trying to build a grade without a location survey and blueprints. They have had little or no dealing with the footings. They have failed to consider or relate the inherent limitations of their raw materials, transportation, markets, etc. They have been smugly content the while like a manufacturer of locomotives who designed, built, and tried to sell rolling stock without having considered the gauge of the tracks upon which it must be operated.

Only here and there and now and then has there been any serious effort to supply the fundamentals and base data upon which an engineered agriculture must rest and these instances have often been indirect and inadvertent.

With soils obviously a chief item in the availability of lands for different styles of agriculture, our soil surveys have been taxonomic affairs, principally concerned with classification and scientific nomenclature and dealing but little, and then briefly and incompetently, with the factors affecting the profitable utilization of the soils and lands surveyed and reported upon.

Our standard (if they are standard) "farm management surveys" have resulted in tables of family and labor income, and the like, with the sizes of the farm units considered but with nothing given as to the soils in which the reported farms were operating.

Our forest surveys have usually been concerned with reporting the board measure or cubic volume of merchantable timber and with estimating the cost of its extraction and have seldom dealt with the factors of soil, probable effect of lumbering, and cost of reproducing the crop.

Our so-called "biological surveys" have usually resulted in long lists of ecological data with as much accent on the ring-tailed wumpus and two-spotted dodger as upon trout or deer.

And so on through the long list of "surveys" which seemingly should but which do not supply the base data for the intelligent utilization of land.

The fact is, of course, that the specialists who have devised and operated these various technical surveys were not engineers and were but little, if at all, interested in the practical phases involved. Indeed, not uncommonly, the specialists have exalted their thin sciences and sneered at the mere and crude "practical application" of their pure scientific works.

There is nothing abnormal in all this. Every branch of engineering has had to fight through the precedents and orthodoxies before it got a chance to function. Agricultural engineering can hardly expect to be an exception.

The developments—and lack of "development"—which led up to the creation of the Michigan Land-Economic Survey were not peculiar to Michigan. But Michigan is the oldest of the states where great forests were lumbered off under modern wholesale practice and is, therefore, farther advanced in cut-over country experience and therefore, perhaps, logically the place to initiate a new idea.

This new idea has to do with the intelligent use of land. It has been found that the old ideas as to land utilization and "development," cannot be depended upon—have failed.

Something like a third of Michigan is idle and virtually unproductive land, and this after a generation of wholesale booming. The history, detail, and results of this booming have been described in other places; the fact alone is noted here.

It must also be noted that during all this booming of the cut-over lands in Michigan, Wisconsin, and Minnesota, and through the southern pine regions, the regular authorities in agriculture seldom, if ever, intervened to prevent or correct the frauds, misrepresentations, and misconceptions which befogged the situation. To what extent this was due to incompetence and blind optimism and how much of it was lack of common courage will long be a question, but the results, in either case, are the same.

The last colonization and grazing boom came in 1918.

In 1920 came the new census, and the slump in agriculture and, at last, something like an effort to check up and take stock of the situation.

Now it was found that the shrinkage in improved farm lands, long considered a mystery in New England had spread south and west until nearly every state east of the Mississippi was affected, and the total increment of newly improved farm land barely balanced the shrinkages. In spite of all the experiment station technique and all the back-to-the-land, lime-alfalfa, and other slogans and campaigns, old farm land was steadily and persistently going out of business; fields and farms were being junked by the thousands and tens of thousands, and nearly everywhere. Why?

For one reason (seldom mentioned), industry had moved south and west. Farming and industry were now in competition in regions other than New England.

This, of course, permitted people who previously must farm, and who were farming lands and combinations which did not and could not pay good wages, to escape from pauper farming into industry. They went. Their fields and farms (which never had and could not pay them wages) went back into the brush from which they had originally come.

By now the professional economist was getting on the job. The economist's analyses were showing that low interest and lower wages were normal in even the best of the corn belt and that a rather shocking percentage of farms were marginal or worse. Here was precise confir-

mation of what the census had long been showing. The base data upon which any engineering of agriculture (intelligent use of land) must be based, begins to become available.

In canvassing our idle lands in order to locate "suitable" sites for hypothetical soldier's and sailor's farm colonies, Washington for the first time prospects the geography and extent of our unproductive areas. Millions and tens of millions of acres of more or less "suitable" land are discovered, but that boom also bursts and, almost without warning, it is found that the big projects of the U. S. Reclamation Service are in trouble of long standing.

Inquiry develops the fact that many of these projects are really bankrupt. Dozens of privately organized irrigation, drainage, and colonization projects ditto.

Now the new Bureau of Agricultural Economics begins to function. Presently we are getting precise and graphic analysis of our land affairs. Engineer's technique is being applied to agriculture.

Next, the Secretary of Agriculture himself announces to the U. S. Senate that the long prophesied shortage in essential forest products has actually arrived and is worse than anticipated—due to be much worse before it can become better. Special investigations by the Senate and by the Chamber of Commerce of the United States confirm the Secretary's findings.

It is reported that it will require some 400,000,000 acres in continuously productive forests in order to maintain our present rate of consumption. Also that our present farms contain more woodland than the sum of corn, cotton, and wheat land.

In the yearbooks of the Department of Agriculture, the history of land utilization, crop by crop and by acreage per capita, for farm and forest products, is charted and graphed in familiar engineering terms, and projected against the population curve—with results astonishing to the old timers in the colleges. We have plenty of suitable land for food and textile crops; barely enough, if all of it is promptly and wisely used, for forests.

The Harding national conference on agriculture calls for "a classification of land" with a view to adjusting each type and location to its most efficient utilization—or perhaps non-utilization if no form of use promises to be economically justified.

What is this but a demand that agriculture be engineered? The need and the opportunity, at least, are perceived and announced. The base data upon which any intelligent and decently engineered plan and policy as to land utilization must be based begins to appear. In effect, the random lines have been run in and sketches of the layout have been made.

But it is, as yet, all vague and general. It is evident that we must reorganize our theories and practice as to land utilization, so as to orient them according to sound economics and engineering, but how is it to be done, by whom, and through what agencies?

Evidently we must somehow formulate and then administer some fairly definite and specific plan which can be applied to given areas or whole regions.

Here, for instance, is north Michigan, typical and oldest of the cut-over regions, full of great stretches of devastated forests, brush, stumps, and snags, with little woeful settlements here and there. Its economic condition is certainly bad. How bad nobody can say. As to the precise conditions, nobody has ever inquired.

But if the region has a future, that future must certainly lie between farms, forests, and the recreation industries, including game, fish, and fur. The essential is land permanently and profitably at work—at something—at anything which is reasonably permanent and profitable. There must be development; real development this time, and no more fever of raping extraction and then a wholesale junking of lands and people, mills, farms, railroads . . .

What can be done and what should be done cannot be determined until the essential facts are available. No agency for getting and reporting these essential facts, the facts on which any intelligent plan or policy of land utilization must be based, was in existence. One must be created. Therefore, the Michigan Land-Economic Survey.

In cooperation with the U. S. Bureau of Soils, the Survey is making an inventory of soils and topography.

In cooperation with the U. S. Lake State Forest Experiment Station, the Survey is making an inventory of forest cover, past and present.

In cooperation with the Institute for Research in Land Economics the Survey is making an inventory of the economic history and status.

In cooperation with the U. S. Geological Survey, the Survey is making inventory of the mineral and water resources.

As needed, specialists in peat, marl, archeology, and what-not are called in. The agricultural college and the university are in close contact. The state department of agriculture assists. The state department of conservation operates the Survey.

The maps show on a 4-inch scale, the land net and civil base data. They show soils and topography. They show forest and all other cover. They show present and past forms of land utilization and in detail permitting the planimeter analysis of such items as stump pastures, cultivated land, orchards; dense, medium or thin "popple" or maple, or pine, and the prevailing diameters of each stand. They show abandonments and new settlements and the ratio of each crop actually found growing in the fields, soil by soil and section by section. They even show the character of aquatic vegetation and building sites for summer homes and bathing beaches.

The report covers such items as changes of population in each political subdivision, assessed values of land by each class of title and soil, tax history, carload exports and imports from principal shipping stations, and the like.

Some two million acres have been covered to date. Field and office technique is now well settled and past the experimental stage. The cost of field work is running below five cents an acre, and grows less as the crews develop experience and skill.

It is an inventory job. The Survey is after the essential data on which any intelligent plan and program for the utilization of these lands must be based. It assumes that the data will presently be used to devise and administer parallel and harmonious programs for the development of farms, forests, and recreation resources, when and where each is justified and in the relative order of justification.

The Survey itself makes no plans and offers no advice but its maps and reports show so clearly and inescapably the results of past experience, that the conclusions, respecting any given type or tract of land, are usually quite obvious; if not, then the fact of doubt is itself made clear and is of enormous importance.

The full technique of the Survey is so complex and so novel that it is hardly practicable to describe it in detail. The important thing is that it has been worked out, tested, and well proven. It is demonstrated that the essential information upon which farm, forest, and recreation developments in this region must be based, if intelligent, can be had at little cost.

It is not yet demonstrated that there is available enough intelligence to permit or encourage the sober and skilful application of the base data and its use in devising the specific procedure and construction requisite to the wholesale engineering of land affairs. But economic pressure is a potent stimulus and near a million acres of Michigan land have gone bankrupt for back taxes and have been thrown to the state; millions of acres more, delinquent, are on their way. A like situation, no doubt, will soon be evident in twenty or thirty states; in many states is already evident in spite of all camouflage.

Once the essential facts are available, the necessary precedure will not be overly complex or difficult. To insure new settlers with the very best chances available should not be hard. To stop the forest fires or plant back the barrens is not too difficult. To know and tend the wild life associated with recreation should not be impossible. Step by step, in Michigan, these things are being accomplished today; not always wisely or well but, nevertheless, we are beginning to engineer the affairs of agriculture.

Economics of the Corn Picker-Husker *

By C. O. Aspenwall

Mem. A. S. A. E. Experimental Engineer, International Harvester Company

AFTER many years of development the corn picker and husker has finally come into its own; it has finally been recognized by the farmer to be just as essential and even more profitable than the grain binder

This recognition is well supported by facts. In the yearly harvest of the United States there are about four times as many bushels of corn as of wheat. The average annual wheat crop is about 800,000,000 bushels, while the average annual corn crop is well over 3,200,000,000 bushels, so there is really four times as much reason why there should be a demand for a machine to harvest corn as for a machine to harvest wheat. Probably one of the strongest reasons why the corn picker has not come to the front faster is because of the longer period the farmer has for harvesting his corn crop as compared with wheat.

It may be interesting to say something about the early history of the corn picker. Please bear in mind that there are on the market three different machines for harvesting corn—the corn picker, the corn picker and husker, and the corn harvester. The corn picker simply snaps the ears of corn from the standing stalk. The corn picker and husker not only snaps the ear from the stalk, but also removes the husks from the ear. The corn harvester cuts the standing corn and ties the stalks, with the ears attached, into bundles.

Looking into the records, we find that the first patent issued on a corn harvester was to E. Quincy of Lacon, Illinois, on October 8, 1850, nearly 74 years ago. His claim was for a machine to strip the heads from wheat, Indian corn and other grains and seeds, and as harvesting processes go at the present time it would seem that he took in a lot of invention territory.

The second patent was issued to William Watson of Chicago, Illinois, that same fall, on October 15, 1850, but his device is described as a corn harvester for Indian corn only.

The first patent for a corn harvester with spiral or terete rollers was issued to Richardson, White and Weed of Grayville, Illinois, on June 14, 1859. The first patent issued on a corn harvester with cylinders provided with right and left-hand spiral flanges was to Hill and Harpham, Havana, Illinois, on October 29, 1867. Their invention contained the same principle on which snapping rolls are built at the present time; in other words, that idea is now about 57 years old.

The machines invented and patented up to that time were all described as corn harvesters and the patentees were all from Illinois, but on August 22, 1871, a patent was issued to Leonard Devore of Victor, Iowa, covering a corn harvester and husker.

These patents I have specified are not the only ones issued during this time covering machines intended for harvesting corn, but were the first patents issued covering the several distinct types.

A great many other patents were issued covering machines for harvesting corn from the stalk in the field, but after 1871 for a number of years little if anything was done in the way of inventing or patenting corn harvesters or corn pickers, and it was not until J. A. Stone of Vail, Iowa, was granted a patent on a corn harvester on September 4, 1888, that the developing of machines for corn picking and husking was revived.

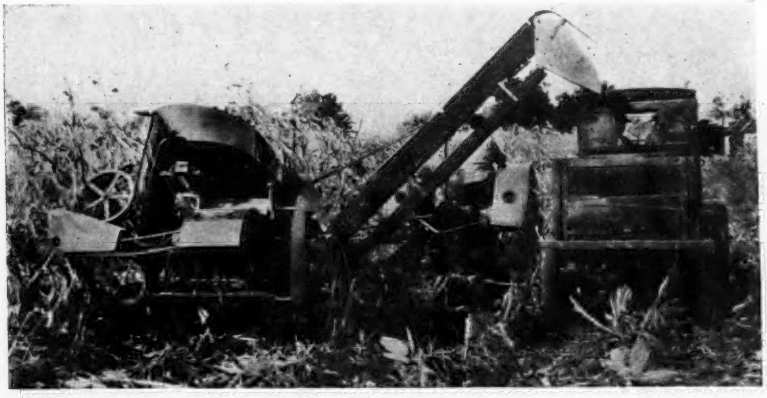
It was in the fall of 1888 that William Deering went to see Mr. Stone and his machine, and took both man and machine back with him to the Deering factory where Mr. Stone spent a great many years, in fact the remainder of his life. Practically his entire time was given to developing and perfecting the present corn picker and husker, and he did not work alone on this machine but had the help of several other inventors and designers. Some of these, like Mr. Stone, have passed on, while others are still at work on the machine trying to see what more can be done to perfect it.

To sum up, it is nearly 74 years ago since the first patent was issued for a corn picker and 35 years since we commenced developing the present machine. While we have had a commerical machine for a number of years, it was not until two or three years ago that we were able to convince any great number of farmers that the corn picker and husker was a profitable machine for them to own and was really just as essential as a grain binder or a mower. The amount of time and money it has taken to develop and get the farmer to accept the corn picker and husker is incredible; the introduction of the grain reaper to general use was hard and slow enough, but the history of corn picker distribution has been worse.

(Continued on page 202.)

*Eighteenth annual meeting paper.

Unquestionably the corn picker-husker is the most important of the newer farm labor-saving machines. It has been a slow process getting farmers educated to it, but now it is rapidly coming into use. It is most successfully operated when hauled by a tractor, which furnishes the power for driving the machine through a power-take-off. A motor truck to receive the husked corn completes a modern all-mechanical-power outfit.



Agricultural Engineering from the Farm Equipment Manufacturer's Viewpoint *

By H. J. Hirschheimer

President, National Association of Farm Equipment Manufacturers

THE manufacture of farm equipment is really a branch of Agriculture; one in which every farmer is vitally interested. There is a splendid opportunity for closer contact between the agricultural engineers and the farm equipment manufacturers. We have handed each other verbal bouquets in contact meetings, but there has been no real constructive cooperation until the past year or two. I refer to the disk harrow and left-hand plow investigations conducted by your society, and the most recent move —the formation of the joint committee on cooperative relations.

Research was an unknown word back in the early years of the farm equipment industry. New tools were developed over the hammer and anvil, not over the drafting board. First the country blacksmith and then the small manufacturer developed tools by the cut-and-try method. Tools were built for local conditions only. Many fundamental farm machinery ideas were originated by farmers who went to blacksmith shops and had these new ideas or improvements hammered out.

The expansion of the farm equipment industry into its present state came as a natural result of efforts to give better service to the farmer. Quantity production, far-reaching sales and distributing organizations, experimental farms, and schools of instruction are evidence of this.

It is possible that the lack of closer contact between educational institutions and the industry has been due in a measure to the basic education of the manufacturer. He has been brought up to work out his own problems within his own organization, and it probably seldom occurs to him that there is a capable agency for research, experimentation and testing in every state, ready and willing to serve.

Prof. M. L. Nichol's article on agricultural engineering research in the February, 1924, number of AGRICULTURAL ENGINEERING impressed me with how little I knew about real research work. I have spent thirty-three years in the manufacture of tillage implements, plows particularly, and I can confess I know absolutely nothing about soils and soil action from a technical standpoint. We can build a plow to meet certain conditions, yet we have not the least idea why it works one place and fails in another, except as a matter of shape. This statement is a personal one covering our own experience, yet I believe it will apply to many producers.

Due to the handicaps under which agriculture has been laboring the past few years, the farm equipment industry has been going through a period of depression fully as severe as that of agriculture. It seems to us that a great deal of this is due to a mistaken idea of use of implements. There is a sharp dividing line between patching up old and discarded tools and the use of new labor-saving equipment. There has been a lot of propaganda covering and recommending to the farmer that he make use of his old or discarded equipment.

Where would manufacturers be in this country if we followed this mistaken idea of economy? No progressive manufacturer hesitates to discard a machine if it can be replaced with a more efficient machine, one that will produce more units per day, or one that will reduce the cost of manufacture.

The purchases of farm equipment are about fifty per cent of normal the past few years. Prof. C. O. Reed, of the University of Ohio, has computed the deficit in purchases of farm equipment, 1919-1923, as nearly six million machines. We averaged $43.00 spent per farm last year for purchase of new machinery. This is less than the average automobile tire bill per farm .

I want to call your attention to one very significant fact. While out domestic sales have shrunk to fifty per cent of normal, our export trade has nearly doubled. Fifty million dollars worth of farm equipment was exported in 1923. Probably you have seen the figures without realizing what it really means to the American farmer. This is what it means: While the American farmer is operating with old and partly obsolete equipment, under false economy, his principal competitors in the markets of the world have greatly increased their purchases of new machinery. Let me illustrate. In 1923 we exported 20,154 tractors— 5867 went to Canada, 2100 to Argentine, 2841 to Australia, 1200 to Denmark, 1200 to France, 843 to Bulgaria. If we eliminate France, it leaves nearly 13,000 tractors purchased by these leading competitors of the United States, who produce wheat at prices which are below the cost of production in the United States. Isn't this significant—the American farmer cutting his purchases in two and the foreign buyer doubling his purchases of labor-saving equipment?

I use tractors merely as an illustration; the same thing will apply in like measure to plows, grain drills, etc. It seems to me that these facts must impress on you the fact that the man who is buying farm equipment is the one who is going to lower his cost of production and hold the market for himself.

One more illustration: While average purchases of new farm equipment in the domestic market are about fifty per cent of normal, the purchase of new grain drills is much less than this average. How much is the yield per acre affected by the use of old drills or by the use of broadcasting devices instead of drills? Here is a direct illustration of increased cost of production due to use of inefficient tools.

There is an opportunity for real service to the farmer through cooperation between the colleges and the industry, in encouraging the use of both labor-saving and increased-crop-making tools.

The National Association of Farm Equipment Manufacturers offers a point of contact for giving greater publicity to standard farm practices that are being developed by farmers in conjunction with the efforts of various colleges. On the college side there is a real opportunity to bring to the attention of the farmer, through the students, the kind of equipment used by the best farmers.

As an illustration, a new bulletin of the N. A. F. E. M. research department is just off the press. It covers corn growing practices in Illinois, Ohio, and Indiana. The results of the 100-bushel corn clubs show that tractors and deep plowing figure prominently as contributing to the successful results and that the land roller is a standard piece of equipment with all club members.

Don't misunderstand this as propaganda, any more than you would Prof. G. W. McCuen's study on motorizing the corn crop published in farm equipment trade papers in June. This shows a saving of 62.7 per cent in all operations up to and through cultivating, by use of motors. These are facts that should be in the hands of every farm-

*Address before the eighteenth annual meeting of the Society, Lincoln, Nebraska, June, 1924.

er who wants to reduce his operating costs and increase his crop yield.

When farmers are as careful in the selection of seed and the planting of small grains as they are with corn, they will be able to get better yields and overcome the declining yield per acre. Increased efficiency, greater output per man through the use of modern labor-saving equipment, is the solution of the present difficulty.

By fewer people producing crops and greater numbers being available for industry, the distorted balance between farm prices and earnings and industrial wages and earnings can be restored. The demand for foodstuffs is not cumulative. The demand for textiles is. The country may curtail its purchases of cloth, but eventually it comes back into the market to replenish its stock. There is little variation in per capita demand for food from month to month. There is no carrying over the nation's appetite from one year to another.

The American Society of Agricultural Engineers can help both the farmer and the farm equipment manufacturer. But chiefly through the education of the farmer to increased efficiency, better yields, and lower cost of production is the manufacturer going to be placed in the position of greatest service to agriculture.

Power Required to Drive Farm Pumps

By J. S. Baker

President, Baker Manufacturing Company

TESTS made recently on the power required to drive pumps may be of interest to agricultural engineers.

We experimented with a three-way underground force pump with a 1¼-inch opening and a 3-inch brass-lined cylinder. The water was pumped through about 30 feet of 1¼-inch pipe, one right turn; 30 feet of 1½-inch pipe, three right turns; and 120 feet of 2½-inch pipe, to an elevated tank.

When the pump was at rest, the difference between the top of the water in the well and the tank was 75 feet. With the pump making thirty-seven 7½-inch strokes per minute, it is probable that the water was elevated 77 feet. With fifty-four 10-inch strokes, it may have been 83 feet. In all the calculations, it was assumed that the water was raised 77 feet.

The pump was driven by a double-back, spur-geared pump jack, and the jack was driven by a ½ horsepower repulsion electric motor. Two different motors, designated "A" and "B", were tested.

The motor was enclosed in a metal weather-proof ventilated house, the motor pulley being directly over the jack pulley. The motor was mounted near one edge of its base on a hinge, the axis of which was parallel to the motor shaft. The motor was pressed upwards by a spring under it, with sufficient force to overcome the motor's weight and automatically tighten the belt.

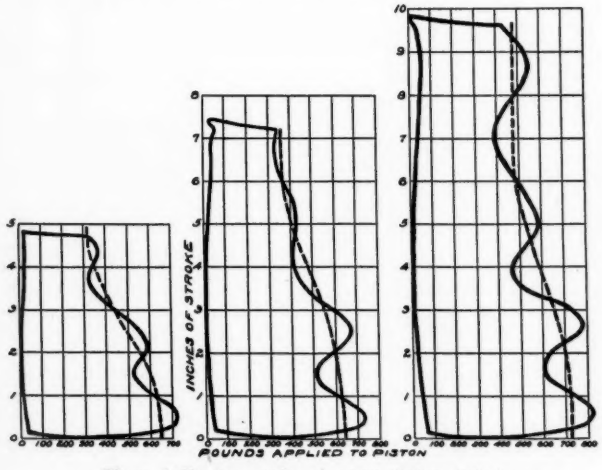
All the machinery, except the motors, was of our manufacture.

The power delivered to the motor was measured by a Westinghouse watt-hour meter. The power delivered to the belt was obtained by multiplying the power delivered to the motor by the efficiency of the motors at that particular load. The efficiency curve had previously been determined by other tests.

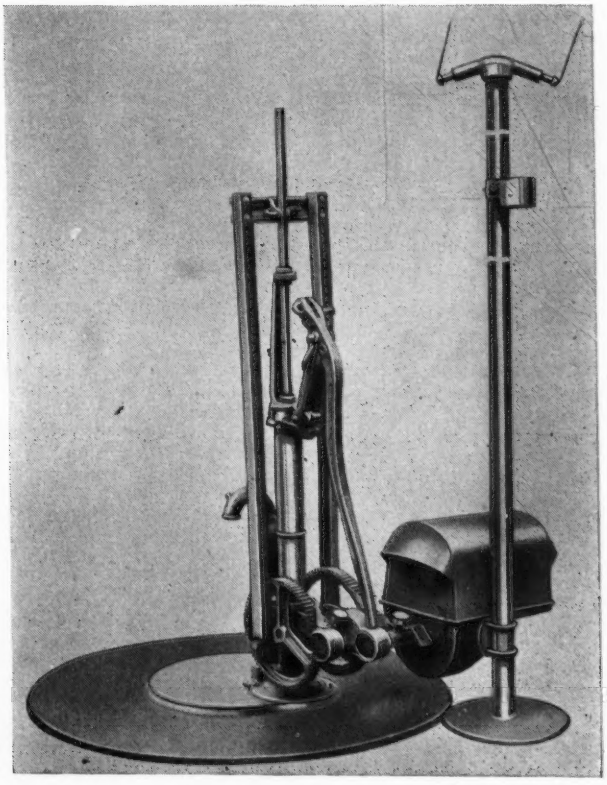
The power delivered to the pump was obtained by a homemade apparatus, which makes a card similar to a steam engine indicator card, the height of the card representing the length of the stroke and the width representing the force applied to the pump piston at various points in the stroke.

The pump jack crosshead was not connected directly to the pump piston, but indirectly through a heavy compression spring, which, when force was applied, would permit the crosshead to move up on the piston bar a little.

On the piston bar was mounted a bell crank, in a vertical plane, with a 2-inch horizontal arm connected to the crosshead with a pitman; the lower end of the 12-inch vertical arm contained a horizontal pencil. A force applied



Three indicator cards of pump being tested



This picture shows the equipment used in making the tests

TABLE OF RESULTS OF TESTS ON PUMPS

Horsepower of Motor		"A" ½ horsepower		"B" ½ horsepower	
(1) Length of stroke		5 inches	7 inches	5 inches	7 inches
(2) Number of strokes per minute		39.00	39.00	42.00	39.00
(3) Horsepower delivered to motor		0.37	0.53	0.59	0.67
(4) Horsepower wasted in motor		0.16	0.18	0.35	0.31
(5) Horsepower delivered to jack		0.21	0.35	0.24	0.36
(6) Horsepower wasted in jack		0.015	0.025	0.015	0.025
(7) Horsepower delivered to pump		0.195	0.325	0.225	0.335
(8) Horsepower wasted in pump and water		0.075	0.14	0.095	0.155
(9) Horsepower to raise the water		0.12	0.18	0.13	0.18
(10) Efficiency of motor	(5) ÷ (3)	57.00	65.00	41.00	54.00
(11) Efficiency of jack	(7) ÷ (5)	93.00	93.00	93.00	93.00
(12) Efficiency of pump	(9) ÷ (7)	61.50	55.50	58.00	54.00
(13) Efficiency of motor and jack	(7) ÷ (3)	52.50	61.40	38.00	50.00
(14) Efficiency of jack and pump	(9) ÷ (5)	57.00	51.50	53.00	50.00
(15) Efficiency of motor, jack and pump	(9) ÷ (3)	32.50	34.00	22.00	27.00

to the piston bar through the spring would compress the spring and move the pencil horizontally. It was found by experiment that 576 pounds, applied to the piston bar, moved the pencil 3 inches horizontally. The pencil would also move up and down with the pump piston.

A paper was fastened to a small vertical board with a horizontal base, which rested on a horizontal table with a strip along one edge parallel to the axis of the bell crank. With this construction, the paper could be maintained in a vertical position parallel to the plane in which the point of the pencil moved, and be moved towards the pencil until the pencil would describe a card. From this card, the horsepower delivered to the pump piston bar could be computed.

Three of these cards are shown in an accompanying cut. The only difference in the conditions under which they were made is the length of the stroke, and the slight variation in strokes per minute. The vertical lines are 100 pounds apart, and measure the force applied to the pump piston. The horizontal lines are one inch apart, and represent the piston travel. The dotted lines show the shape of the cards with the waves smoothed out. They show nearly a constant force applied to the pump piston at the beginning and end of the strokes. This is what would be expected, because the acceleration at the beginning and end of the stroke is nearly uniform.

Through the middle of the strokes, when the plunger speed is practically constant, the force drops rapidly. At the middle it is practically the force exerted on the pump piston without inertia effects. At very low speeds the cards are rectangular, and at higher speeds the forces at the beginning of the stroke are larger and at the end of the stroke are smaller than in these cards.

The accompanying table shows the results obtained with "A" and "B" motors on 5 and 7½-inch strokes. "B" motor drove the pump 42 strokes per minute on the 5-inch stroke; otherwise both the motors pumped 37 strokes per minute.

The cylinder used in making the tests in this case had a single leather plunger which had been thoruoghly worked in.

We also made experiments to ascertain the effect of speed on the efficiency of the pump. In this case, the jack was not driven by an electric motor, but by a three-horsepower gasoline engine, and the speed changed by the use of different sized pulleys. A two-leather plunger was used in the well cylinder, and it was thoroughly worked in.

The efficiency curve is very nearly a straight line. In the calculations, no correction was made for lowering the water in the well by fast pumping. Had this been taken into consideration, the efficiency curve would have been more nearly a straight line.

Experiments to determine the coefficient of friction of wet leather on polished brass, and the dimensions of the cup leathers, would indicate that a pump efficiency of 70 per cent would be obtained at slow speeds with single-leather plungers.

We did not actually make this slow speed experiment for single-leather plungers.

Our experiments with single and double-leather plungers indicate that about 9 per cent more power is consumed with the double-leather plunger than by the single leather —around 35 strokes per minute.

Economics of the Corn Picker-Husker

(Continued from page 199.)

The present successful machine was in practically the same form in 1905 as now, yet in almost all that nineteen year period it has been sold only in very limited numbers, despite all the force and expense put behind the sales efforts. Now the tables have turned and the farmers—the ones who have had experience with the machine—are making much larger claims for it than the manufacturer or seller.

It may be helpful if I present briefly some of the statements that have been made by users of the corn picker and husker and some of the experiences I have personally had with it in the field.

The present machine picks and husks one row of corn at a time. It is arranged to be pulled by five horses or by a tractor, and when it is so desired and where the tractor is so constructed, the mechanism of the picker and husker can be driven by a power-take-off attachment from the tractor. The capacity of the machine in bushels per day depends chiefly on the yield per acre, the speed traveled, and the working hours.

One very acceptable condition to the farmer is that up to a certain point the worse the weather the better the machine works. It works best early in the morning or late in the evening or during a heavy mist, so the farmer can put in long days and many of them.

The machine will cover from 5 to 7 acres per day when pulled by horses and up to 10 or 12 acres per day when pulled by a tractor. In fact, I have been in a field and observed one of these pickers and huskers pulled by a tractor with a power-take-off running four miles per hour, covering about 15 acres per day.

But for comparisons let us consider averages and these clearly show that a corn picker and husker pays. The majority of the machines are pulled by horses, so we will first figure on the horse-drawn machine, traveling two miles or a little less per hour and ten hours per day. This would cover about seven and one-half acres per day. Let us cut that still further and figure six acres per day in corn running fifty bushels per acre or picking and husking 300 bushels per day. In addition to the machine, this requires 7 horses, 2 wagons and 2 men.

Picking and husking corn by hand in the old-fashioned way is getting harder to do every year; this kind of work is about where binding grain by hand was forty years ago and the price for husking is increasing each year. The price paid to hand huskers in the fall of 1923 in Iowa, southern Minnesota and South Dakota ran from 6 to 12 cents per bushel, depending on the condition of the crop, the yield, the distance to unload and the facilities for unloading. In addition to that the man gets his board and washing, but for comparison we will take the next lowest figure, 7 cents per bushel, and then we will estimate that a good man can pick and husk 1½ acres per day of ten hours. Put an outfit of two of these good men and a team in the field, at this rate it will take the two men 33⅓ days to husk the 100 acres. At 50 bushels per acre the field would yield 5,000 bushels and the cost would be as follows:

(Concluded on page 208.)

Research Methods in Agricultural Engineering

Research activities in the agricultural-engineering field are presented under this heading by the Research Committee. Articles dealing purely with the manipulation of research methods and equipment are featured. Members are invited to discuss material presented and offer suggestions on timely topics

Some Research Features of the Application of Electricity to Agriculture*

By R. W. Trullinger

Mem. A. S. A. E. Specialist in Rural Engineering, Office of Experiment Stations, U. S. Department of Agriculture

(Concluded from the August issue.)

Other studies conducted in England (54)** on the respiration of plants under various electrical conditions showed that an increased crop or earlier maturity may be the result of electrical treatment. Direct currents of a density of from 10^{-6} to 10^{-4} amperes had no effect on the respiration of peas other than that due to accompanying changes of temperature. Overhead discharges producing a current of density less than 3×10^{-6} amperes had no effect on respiration. Electrification had no influence on respiration in the field either, so that any growth acceleration is due to stimulation of other plant functions than respiration. Further studies (55) in England on the distribution of overhead wire network at a high potential is a variable quantity, depending upon the mobility of the carriers of electricity and on the wind velocity. Measurements of potential gradient and of current density agreed in showing that the effect of the discharge is not limited to the area under the wires. Further studies on this feature (56) showed that screens surrounding electrified areas must be higher, the carrying wires lower, and the plats more completely isolated by screening and by location with reference to the prevailing winds. Separation of experimental from control plats by a distance of at least 100 yards was indicated by other studies (57).

German experiments (58) on the influence of high frequency currents on plants showed that large increases in growth and chlorophyll formation of several common vegetables were due to the oscillating field of an alternating electric current of very high potential and rapidity of oscillation and not to the heat generated by the current.

Russian experiments (59) shower that while atmospheric electrical influence increased crops, especially when employed during the hours of sunlight, its practical employment was not warranted.

Additional English experiments (60) showed that overhead electrification markedly increased crops such as oats, especially when the intensity of the discharge was increased by lowering the wires, by reducing the distance between wires, and by reducing the thickness of the wires.

Experiments in Scotland (61) on the overhead application of a high tension electrical discharge to oats, barley, hay, potatoes, turnips, and swedes grown in rotation during a period of five years failed to produce sufficient increases in yield to repay the cost of the treatment.

Three years' studies at the Missouri Botanical Gardens (62) on the overhead electrical stimulation of truck crops showed increased yields and earlier maturity but indicated that before any definite practical application can be made it will be necessary to establish (a) quantitative measurements of the electrical discharge, (b) the different stimulating actions on plants at different stages of life, (c) the effect of intensity of the stimulus and the time of application, and (d) the length of time elapsing between the application of the stimulus and the occurrence of the stimulating effect.

Experiments in South Wales (63) demonstrated the effectiveness of a network of No. 24 steel wire meshes 6 feet square and straight wires 9 feet apart suspended 5 feet above ground and through which was passed a current varying between 30,000 and 39,000 volts in increasing the potato crop on heavy loam soils.

Experiments conducted at the Kentucky station (64) showed that in general smaller crop yields were obtained on electrified plats than on nonelectrified plats with the exception of potatoes.

Pot experiments at the Rothamsted experimental station in England (65) showed that an overhead electrical discharge accelerated reproductive growth of barley apart from vegetable growth. Field experiments indicated that with overhead wires set a distance apart not much in excess of their height fully half of the current supplied to the wires reached the crop. Further pot experiments at Rothamsted (66) indicated that alternating current is usually as effective or more so than direct current, and that upward current through the plant increases growth the same as downward current.

This summary, while incomplete and indicative of contradictory findings, shows the numerous lines along which possibly profitable investigation may be undertaken on the overhead electrical stimulation of crops. While obviously the main object of most of this work has been to determine the nature of the influence of overhead stimulation on plant growth phenomena, it would seem that too little attention has yet been given to the actual requirements of optimum growth and yield and the corresponding amounts, rates, frequencies, manner of application, and other characteristics of overhead electrical stimulation which may promote such optimum growth conditions.

Electrical stimulation of crops through the soil. The stimulation of crop growth and yield by means of electrical currents passed through the soil has not been investigated so extensively as has the atmospheric discharge method. Nevertheless, it apparently offers an opportunity for development into a possibly profitable process which may add considerably to the electrical load. It is of course merely another kind of electroculture, and its economic value is yet to be established.

Early experiments at the Utah station (67) showed that electricity conveyed by a network of wires 10 inches deep in the soil apparently markedly increased the yield of several field crops, but reduced the yield of turnips.

Experiments at the Massachusetts station (68) in which noninsulated copper wires connected with a dynamo were placed 2 inches below the surface of rich soils, showed a favorable influence of such electrical stimulation on the yield of parsnips, radishes, carrots, lettuce and turnips, while the yields of sweet German turnips and Egyptian

*Eighteenth annual meeting paper.

**The figures in parenthesis indicate references that follow this paper.

beets were decreased. The ripening of tomatoes was hastened by such stimulation.

Numerous experiments in Germany (69) on the influence of electric currents on crops and soil organisms showed, on the other hand, that a constant current is injurious to both germination and development of plants. This influence was most marked immediately between the electrodes, and tension, current strength, duration, soil conductivity, and general soil composition as well as electrolysis seemed to be factors influencing the degree of injury. In this connection French experiments (70) showed that the influence of an electric current upon plants was quite different on soils of varying chemical composition.

Experiments at the Massachusetts station (71) showed that apparently the effect of positive and negative stimulation of plants offers a mechanical explantion of the positive and negative galvanotropism in roots. When plants were grown between positive and negative electrodes, each electrode exerted a characteristic influence on the root, and that surface of the root nearest the anode was affected according to the nature of the stimulus on that side. When weak currents were used the positive current gave the greatest stimulation to those cells on the anode side of the root and induced bending in the root toward the negative pole. On the other hand, strong positive currents induced bending toward the anode, due to retardation or injury of the cells on the side of the root toward it. It appeared that increasing the electrical tension of the atmosphere, either by the use of static charges or by the use of high tension wires, caused a greater degree of stimulation than passing the current through the soil. Alternating currents had a greater stimulating effect than direct currents.

Somewhat in contradiction to these results, western experiments (53) showed that a direct current passing through the soil containing the seeds or roots of plants caused a gain in root structure and the electrified plants after transplanting were more hardy and grew faster than the nonelectrified. Similar tests with alternating current gave positive results only under very low power values.

The apparently contradictory nature of some of these results would seem to indicate the importance of learning more about the requirements of optimum plant growth in different kinds of soil. Evidently soil composition has an important influence on the stimulation of crops by electricity, and the nature of the current whether direct or alternating seems to merit consideration.

Treatment of seed and seedlings by electricity. Work on the electrical treament of seeds has apparently been divided into electrochemical treatment and attempts to effect direct stimulation by electrical currents. The former process consists essentially of passing a current of electricity through a solution of common salt or some other compound in which the seed is immersed. Experiments have been conducted on this process in Canada (72), in England at the Rothamsted experimental station (73), and at the Arlington experimental farm in the United States (74).

Most of these experiments did not bear out the claim that such treatment increases the yields of such crops as wheat. The Arlington farm experiments especially showed no benefit or profit resulting from such treatment. In fact, the grain yields from treated seeds averaged 1.1 bushels per acre less than those from untreated seed. The purpose in mentioning this process is merely to show its status as a rather unpromising possibility as a source of a profitable electrical load.

The direct stimulation process, however, seems to offer a slightly more favorable prospect. British experiments (75), for example, showed that direct currents varying from 0.75 to 9 milliamperes produced a decreased respiration of germinating seed of from 20 to 30 per cent. Where the current was rapidly reversed the lower current produced an increase in respiration, while the higher currents decreased it. The best results were obtained by connecting the positive pole of an electric machine with a platinum loop just above the seeds, the latter being connected with the earth and thus passing a discharge into the seeds.

French experiments (76) indicate that a continued electric current is decidedly injurious to the germination of seed.

These experiments as a whole, while not very promising, indicate the possibility of developing the use of alternating currents of low intensity for the stimulation of seed germination. It would seem that more should be known regarding the requirements of proper germination to be used as a basis for such development.

So far there seems to be more or less certainty that electricity has a favorable influence on the growth and yield of some crops under certain conditions. However the mode of action of such stimulation whether from illumination, atmospheric discharge, or soil treatment is yet obscure. Until that mode of action is made known for the proper crops under specific conditions the resulting electrical load can never be developed with any assurance that it will eventually be a profitable one. Everything indicates that individual investigations on the subject so far have been too cursory. It would seem that there should be a greater systematic variation of conditions and especially of the electrical conditions.

Electricity in Animal Production

While apparently very little investigational work has been undertaken on the use of electricity in the processes specifically related to livestock production, it would seem that this field is worthy of consideration at least as a possible source of a profitable electrical load.

The science of ventilation of animal shelters is rapidly developing and should eventually offer a field for the use of electricity in mechanical or forced ventilation where beef, pork, or dairy stock are handled on a large scale. The use of electricity for the artifical lighting of feed lots to increase the gains in meat stock has also been advanced as a possibility. Obviously more study by animal experts is necessary to determine more definitely what are the light requirements of animals corresponding to optimum feeding conditions. It would seem that this scheme offers its greatest possibilities in winter feeding.

The preservation of succulent feeds and the curing or drying of such feeds as hay and grain by electricity suggests other possibly profitable uses of electricity in matters relating directly to animal production. More or less recent studies on the preservation of green feeds by electricity have been conducted by the California station (77). In this work, alfalfa and foxtail silage treated in three 30-inch tiles with a 220-volt alternating current of electricity for one and two months was in good condition upon opening except for a little decay at the top and around the walls of the tiles. Cattle ate the silage without waste. While this process is apparently so far not very satisfactory or profitable, the results obtained are obviously of such a nature as to warrant further study. Over one hundred instances of apparently successful electrical silage preservation are on record in Germany (39). This experience has shown that objectionable bacterial action is arrested by the electrical treatment, thus better preserving the fodder. Each silo has a ground electrode fixed at the bottom and a live electrode is placed on top of the freshly cut green silage. From 24 to 48 hours of electrical treatment are required and each ton of fodder requires from 13 to 20 kilowatt-hours of electricity.

Hay curing by electricity has been successfully accomplished in experiments conducted in Scotland (39) in localities where the conditions for good hay curing are frequently if not almost constantly unfavorable. Stacked green grass was dried by air blown by an electrically driven fan. The rate of drying was inversely proportional to the amount of moisture suspended in the atmosphere, no drying taking place when the atmosphere was saturated. The curing process required about 30 hours during which 60 per cent of the weight of the grass was evaporated. Hay cured in this manner had a better appearance and smell than naturally cured hay, and its nutritive value was greater. The profitableness of the process was apparently not established, but the results obviously warrant further

attempts to develop the process into a profitable one. It should be noted that the Alabama station has such work under consideraion.

The use of electricity for the maintenance of proper temperatures of the drinking water for stock, especially in winter, seems also worthy of consideration. Of course the prevention of freezing would be a big factor, but it would seem that in the development of such a use a study should be made to determine the optimum ranges of drinking water temperatures for different farm animals. Automatic control of such temperatures by electricity would seem to be quite possible.

Electricity in Dairying

The processes involved in dairying which require heat and power would seem to offer an opportunity for the development of a quite sizeable addition to the rural electrical load. While some experience has demonstrated that electricity may be used in such processes, others have shown that the exact requirements of many of these processes are not quite well enough known to permit an entirely profitable use of electrical energy. German experiments (78) comparing steam and electrity in the work of an average small dairy indicated that electric power must cost as low as 2.5 cents per kilowatt-hour in order to give the economy of steam for both mechanical operations and milk and water heating.

Experiments in New Zealand (79) on the use of electricity in five typical milking plants showed that a 2-horsepower motor was sufficient in most cases for machine milking on the prevailing average scale. Tests made in the United States (20) on an 8-machine milking equipment driven by a 3-horsepower motor showed that the power cost was about 2 mills per cow with electricity at 10 cents per kilowatt-hour. The average load on the motor was 2.3 horsepower and the vacuum maintained by the pump was 15 inches. The New Zealand experiments noted above showed, on the other hand, that for average milking conditions a 3-horsepower motor was uneconomical. Subsequent experiments showed that even a 1-horsepower motor would operate sufficient milking machines to deal with a herd of 100 cows. Since a large proportion of the herds range from 10 to 20 cows, a plant capable of milking two cows at a time is all that is required. The final development in New Zealand is a compact type of machine capable of fulfilling this service and driven by a motor of only 0.25 horsepower. This strikingly illustrates the importance of a better knowledge of economical power requirements in such dairy work as machine milking.

The results of an intensive study of the utilization of power and heat in German dairies (80) to compare the efficiencies of steam power and central station energy showed that under the prevailing operating conditions of dairies central station energy was considerably more expensive than steam. Comparative trials of steam and electric motor power for performing the different operations in dairies in the Dahme district in Germany (81) showed that as a whole the electrical method was more expensive than the steam plant method, although the unit fuel requirement was less. It is thus evident that much is yet to be learned regarding the use of electricity in the heat and power operations in dairying in order to make such use generally profitable.

The flexibility and susceptibility of electrical energy to precise and accurate control would seem to make it a quite desirable form of energy for use in dairying operations such as milk sterilization and pasteurization. British experiments (82) showed for example that bacteria in milk were stimulated by the passage of low electrical currents, and where static electricity was used their growth was favored to a considerable extent by a positive charge. On the other hand, where heavy charges were used the numbers of organisms decreased very decidedly. Experiments conducted at the University of Liverpool (83) showed that by the use of a specially constructed electrical apparatus milk could be sterilized without detriment to its nutritive value and tubercle bacilli could be destroyed. Experiments in New South Wales (84) showed that satisfactory results were attained in the sterilization of milk by short exposure to a high tension electrical current. The milk was not unduly heated, no coagulation occurred, and it was possible to sterilize a continuous stream. There was a complete destruction of all colon and allied bacilli and an enormous reduction in bacteria of all kinds. The milk was unaltered in composition and the enzyms were not destroyed. English experiments (85) on the effects of a rapidly alternating current at high potential in milk sterilization showed that disease-producing and milk-souring bacteria were practically destroyed in the raw product. Further experiments at the University of Liverpool (86) demonstrated that electricity can be successfully applied as a sterilizing agent to milk, with special reference to Bacillus coli and its allies and tubercle bacilli. Similar results were abtained in experiments by the British Board of Agriculture (87). Other experiments (88) demonstrated the effectiveness of alternating current, especially in this process. It thus seems evident that if economy as well as effectiveness can be incorporated in such uses of electricity in dairying practices, a profitable addition can be made to the total rural electrical load. However, everything indicates that more should be known as to the exact result it is desired to accomplish in processes for the sterilization of milk. Preliminary investigations at the Alabama station were recently narrowed down to an effort to determine just how far such treatment should be carried as a basis for the development of economical electrical methods for its accomplishment. This would seem to indicate the necessity for more study on the part of dairy specialists, so that more exact requirements for milk treatment can be advanced for the engineers to meet.

Electricity in Poultry Husbandry and Egg Production

The use of electricity in poultry husbandry and egg production apparently offers another opportunity for increasing the electrical load. Several of the state experiment stations and foreign agricultural institutions have demonstrated the beneficial influence of maintaining proper temperatures in poultry houses, especially in winter, with reference to the comfort, health, and productiveness of the poultry. As far as the optimum range of such temperatures has been determined for specific conditions, it is evident that in some climates artificial heat will be required during parts of the year. The susceptibility of electricity to precise control would seem to recommend its use for this purpose if the exact requirements can be established and the electrical heating can be made automatic. Obviously, however, the facts governing the use of electricity in a profitable manner must be established before the process can be adopted.

A certain limited amount of experience has also indicated the possibility of using electricity as a stimulus to the growth and development of poultry. In experiments conducted in England (89), for example, a chicken house consisting of 6 flats, each large enough to accommodate 75 chickens, was electrified by a large helix of heavily insulated wire wound around it in turns about 6 inches apart. It was found that when the current was applied for 10 minutes every hour during the day there was a mortality of only 1.5 per cent among the chickens and that they were ready for market in 5 weeks instead of three months. In another instance the increase in weight of chickens in the electrified house was about 35 per cent. In still another test electrified chickens were given only two-thirds of the food given to nonelectrified chickens, and after one month the weight per bird was the same.

Experiments in the United States (90) showed that high frequency currents apparently stimulated the blood circulation of poultry by lowering the viscosity of the blood. It was not established whether prolonged electric action increases growth up to maturity or whether its whole effect is to cause the maximum size to be reached sooner. The possibilities of this process are thus plainly evident, although obviously much must yet be learned regarding the nature of the stimulation as a basis for determining the requirements of optimum growth and the best methods of promoting the corresponding conditions by electrical stimulation.

The use of electric light for increasing egg production,

especially in the winter months, seems also to be a quite promising process which will involve the profitable use of electricity. Experiments at the Kentucky station (91) showed a marked increase in egg production during the winter months for both hens and pullets under electric light, although the annual production from hens not under light was slightly greater than from those under light. Similar results were obtained at the Ontario Agricultural College (92) and at the North Carolina (93, 94), Montana (95), and New Jersey (96) agricultural experiment stations. Experiments at the New Mexico station (97) showed that artificial lighting caused a smaller egg production during the winter, although the lighted hens reached the highest point of production and laid more eggs when eggs were scarce. Experiments at the Michigan station (98) indicated that certain unsatisfactory results may follow too much artificial lighting. Experiments at the California station (99) showed that birds in pens electrically lighted both before sunrise and after sunset each day went through a heavy molt in the spring. Those illuminated only at the end of the day molted lightly, while those exposed in the morning hours only did not molt at all. Further experiments at the California station (100) indicated that the main cause of increased egg production from the use of artificial light in the winter seemed to be the resulting longer time during which the birds were able to eat and exercise. Artificial lighting was found to be inadvisable for breeders. It is thus evident that while there is considerable disagreement as to proper practice, the results as a whole indicate that artifical illumination results in greater egg production when eggs are scarce and expensive, but does not necessarily increase the total annual egg production. In fact, there is some evidence that the total production is frequently decreased. However, the difference in the price of eggs when they are scarce and when they are plentiful indicates that the process may be made quite profitable. Apparently, however, there is a problem involved which will require the determination of the best kind, periods, and intensity of illumination for different breeds of chickens under different specific conditions.

A final use of electricity in poultry husbandry which seems worthy of development is for heating brooders and incubators. Experiments at the California station (101), in which a comparison was made of brooders heated by electricity, coal oil, coal, and gas heated hot water showed that the electrically heated brooder was the most economical in labor and fuel consumption when filled to a reasonable capacity. It is worthy of note, in this connection, that the Alabama station has undertaken a study of the electrical control of the fundamental factors entering into the incubation of hens' eggs. The preliminary analysis has indicated that the variable factors of incubation, the effects of which on the embryo should be studied and controlled between certain optimum points, are temperature, humidity, air flow, carbon dioxid, and other air gases, length of cooling periods, and time of turning.

Electricity in Orchard Practices

The greatest use of electricity in orchard practices will probably occur in those operations requiring power such as spraying, cultivation, etc., which may be included under mechanical farm operations requiring power. Another use, the possibilities of which would seem to warrant specific development, is for orchard heating to prevent injury to fruits by late frosts. The importance of the development of practical and economical methods of orchard heating for this purpose needs no emphasis, and considerable work has been done along this line. Experiments conducted by the New Zealand Department of Agriculture (102) showed that the process of overhead electrification had a tendency to prevent frost injury in orchards. Experiments at the Utah station (103) on the relative merits of heat supplied by electric heaters and smudges for the prevention of frost injury in orchards showed that when electric heaters were distributed about in the open in the same manner as smudge pots are distributed in an orchard, 100 horsepower of electrical energy, when converted into heat in the open air, resulted in a temperature rise of 20° F. with an outside temperature of 70° F. Approximately 14 watts per square foot were required to obtain 1° F. rise in temperature. The results of fifteen investigations at other stations agreed in showing that with 100 heaters to an acre, the orchard will remain about 4° F. warmer than the surrounding unheated area. Winds of 10 miles per hour reduced this to less than 1.5° F. On the assumption that the common smudge oils give out 18,800 B. t. u. per pound burned and that a gallon of this oil lasts 4 hours, it has been estimated that these smudge pots developed approximately 6 watts per square foot in raising the temperature of the air in an orchard 1° F.

The use of electricity for this purpose would naturally seem to be out of the question for small orchards. But in the large fruit-producing regions, it would seem that the development of such a use for electricity might be most profitable, especially when it is considered that the use usually meets a very pressing emergency which may mean success or failure of the crop for the year.

The problems involved are numerous, and several of the experiment stations, including the California, New Mexico, and Alabama stations, are or have been interested in solving them. It would seem that more study is needed to establish the ranges of minimum permissible temperatures for various fruits at different stages of early development in different localities to serve as a basis for the development of the most effective and economical means and apparatus for supplying the necessary amounts of heat by electricity. This will naturally involve a consideration of such factors as wind velocity, topography, and climatic conditions.

Combating Insect Pests and Hail by Electricity

Entirely aside from the mechanical operation of spraying, there would seem to be a possibility for the utilization of electricity for combating insect, fungus, and bacterial enemies of plants. Relatively little of an experimental nature has been done on such processes and apparently very little is known. However, the U. S. Department of Agriculture, Bureaus of Entomology and Public Roads cooperating, have apparently found a use for electricity in the dusting of cotton fields by airplane in the fight against the boll weevil. Apparently the use of the electricity is made in so charging the poisonous dust particles that they will be attracted by and held in place on the cotton. How great a use of electricity this process entails is not known. In fact, none of the exact details of the process are apparently as yet available. However, the fact that work is being continued would indicate that the process offers quite considerable promise.

As an example of the more direct utilization of electricity for the destruction of insect pests, it has been found by actual experience (104) that an alternating current of high voltage and low amperage can be passed through the bark of trees or through soil with the result that the insects or other harmful animal pests with which they are infested are destroyed. It has been found, however, that weak currents (82) may have a stimulating effect on some yeasts and bacteria in solution.

Attention may also well be drawn at this point to the results of a French investigtaion (105) which showed that a hailstorm closely followed the course of a 45,000-volt, 8-phase transmission line for a distance of 8.7 miles. The observations indicated that the current had some effect in attracting and directing the storm. Further studies (106) indicated the possibility of using this means for protecting vineyards and crops from damage by hailstorms. While more recent studies have thrown some doubt on the value of this process, nevertheless there should be some consideration of its possibilities in the location of transmission lines with reference to growing crops.

Drainage and Irrigation Pumping by Electricity

There is a record of considerable experience in the use of electricity as power for pumping in drainage and irrigation practices. Naturally the greater part of the experimental work along this line has been done by the U. S. Department of Agriculture, Bureau of Public Roads, and by the U. S. Department of Interior, Bureau of Reclamation.

Exact data on such investigational work can best be obtained from those bureaus. In addition it is interesting to review data from actual large scale experience with this practice. For example, data (107) from 125 electrically driven irrigation pumping plants in the Pomona District in Southern California, operating on both deep-well and low-lift service, show that the cost varied from 2 to 3 cents per kilowatt-hour. Other experience (108) with electrical irrigation pumping on an area of 10,000 acres with 69 motor-driven pumping plants owned by farmers showed that the cost of energy was less than 1 cent per kilowatt-hour as supplied by a central station. It is thus evident that pumping by electricity for irrigation purposes represents a quite sizeable electrical load, which may be obtained at fairly low rates in some localities. It would seem that with this load as a nucleus, provided it is a profitable one, the opportunity for building up a profitable total electrical load on farms in certain of the irrigated sections is quite promising.

Drainage in some of the larger districts of the wet and swampy sections requires considerable pumping. Data on first cost and operating expenses of steam and electrically driven pumping stations used for draining agricultual lands along the Illinois and Mississippi Rivers (109) showed that the cost of building a modern electrical pumping station varies from 50 to 60 per cent of building a steam-driven plant to do the same work. The total operating expense for electrical pumping stations for drainage district service has been found to be from 10 to 35 per cent less than that of steam stations under the same conditions. Everything indicates that the pumping load in drainage districts in large overflowed sections may be sufficient to justify a large part of the expense of installing transmission lines which may also be used for purely farm service. The importance of solving the problems, if any, which are involved in the development of the practice of drainage pumping by electricity is thus plainly evident when considered in the light of the requirements of general rural electrification.

Electricity in Miscellaneous Rural Practices

There are many other miscellaneous either farm or cooperative rural practices which might be so developed both scientifically and economically as to make the use of electricity as the source of the required energy a profitable use. Many of these are direct-drive power uses while others require heat development. For instance, the rural cooperative laundry movement such as that developed in Wisconsin might be the source of a large and profitable enough rural electrical load as to go a long way in justifying the installation of a transmission line. Cooperative destructive distillation of wood and other wastes and refining of raw molasses such as is under consideration at the Alabama station might also accomplish the same result.

Wood seasoning offers an individual miscellaneous use of electricity which may justify consideration in some localities. French experiments (110) have shown, for example, that the passage of an electrical current through a stack of green wood, placed in a large tank filled with a solution containing 10 per cent of borax, 5 per cent of resin, and a trace of sodium carbonate, drives the sap out of the timber and causes the deposition of borax and resin in its place, thus completely filling up all pores and interstices. Other experiments (111) showed that this process increased the resistance and strength of the wood and decreased its liability to decay. It thus seems possible that this process might be developed into a profitable use of electricity in some localities.

Undoubtedly other possibly profitable uses of electricity in miscellaneous farm practices might be brought to light by a careful study and analysis of the requirements and processes required in the detailed operations of different types of farming. The above few have been mentioned to illustrate the possibilities involved in such a development.

Conclusion

A consideration of the results of this study seems to indicate that not enough of a fundamental nature is yet known regarding the exact requirements of the more important processes of specific types of farming with reference to the use of electricity as the required energy, to justify the immediate and arbitrary electrification of large rural areas without a previous and very definite knowledge as to how the electricity may be used profitably as a rather sizeable and more or less constant load.

While a great amount of both fundamental research and investigation has been undertaken by different agencies, much disagreement on important specific points is evident. In other cases the work has never advanced much beyond the suggestive stage, although the progress findings have been quite promising. In still other instances such as tillage the fundamental principles of the practice itself never have been established, thus indicating the necessity first for fundamental research on the process and then for development research on the machinery required to perform the process before electricity can be applied effectively and economically as the source of required power.

In a very few cases the agricultural facts are apparently pretty well established and the remaining work amounts merely to the determination of the requirements for electrical energy and an exercise of applied agricultural engineering. These cases seem to be very much in the minority, however.

It thus seems evident that the rational application of electricity to agriculture will require, first, a large amount of fundamental agricultural and engineering research to provide the backbone of the movement, and, second, a certain but gradually increasing amount of investigational work to determine power requirements and exact electrical applications. Both are important, but the first provides the logical basis for the second.

Regardless of the lack of fundamental knowledge of the subject, this study indicates that the opportunities offered by electricity for the scientific and economic development of agriculture are so great as virtually to demand serious and intelligent consideration of general rural electrification. The humanitarian side of the question alone is so weighty as to forcibly demand consideration. The convenience, safety, ease of control, and general flexibility of electrical power are such great arguments in its favor as to justify the most extreme efforts to extend its use generally to agriculture. To do this profitably it must be done intelligently. To do it intelligently all the facts regarding the exact requirements of agricultural processes and practices must be known not only to best use the electricity but properly to time the operations to provide a constant as well as a large electrical load. Since it is obvious that these facts are not very generally known with reference to the use of electricity as the source of energy, the only solution is to resort to systematic research and investigation following a rational and intelligently prepared program with a view to effecting a gradual and substantial development of processes and practices such that electrcity may be profitably and permanently employed in their operation.

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Economics of the Corn Picker-Husker

(Concluded from page 202.)

5000 bushels at 7 cents	$350.00
Team at $4.00 per day	133.34
Wagon at 50 cents per day	16.66
Board, etc., for two men at $1.00 per day each	66.66
Total	$566.66

Now, then, picking and husking this same kind of a field with a horse-drawn machine at the rate of 6 acres per day would take 16⅔ days, and the cost would be as follows:

7 horses at $2.00 per day each	$233.34
2 wagons at 50 cents per day each	16.66
2 men at $5.00 per day each	83.33
Total	$333.33

This latter total subtracted from the $566.66 leaves $233.33 to apply on the purchase of the corn picker, which is considerably more than half the price of the machine.

So figuring in every way in favor of hand husking, it is an easy matter to pay for a corn picker and husker in two years with a 100-acre field. I know of a number of farmers who say the picker and husker paid for itself the first year.

Then do not overlook the fact that in getting the corn harvest out of the way in 16⅔ days instead of 33⅓ days, you have 16⅔ days left for other work. When the picker and wagon are pulled by a tractor it takes only one team and two men or a man and a boy, and with the increased speed of the tractor over horses 100 acres can be harvested in about ten days.

As to the quality of the work under the two methods, hand and machine, the users of the machines do not hesitate to say that there is little difference. They say that the machine picks up down ears which the hand-husker would not always stoop down for. While there is always a certain percentage of corn left in the field, no matter in what way it is harvested, it is the testimony of those who have had experience in harvesting both ways that the better work and the cleaner harvesting is done by the corn picker and husker.

How Standardization Saves Money

ENGINEERS who have been conducting investigations into simplified manufacturing practice say that in certain other groups of American industries it is probable that simplification and standardization will result in a saving of 25 per cent. If this ratio holds good of the lumber making and wood-using industries group, the annual value of whose production is nearly $4,000,000,000, the theoretical total saving is in the neighborhood of $1,000,000,000.

As the lumber industry becomes more stable and as more efficient methods of distribution and better adjustments of lumber manufacture and lumber grading to meet the requirements of consumers are attained, it is probable that the ultimate saving in lumber manufacture may amount to $300,000,000 to $400,000,000 a year.

Secretary of Commerce Hoover estimates that the plan recently adopted by the lumber industry for standardizing lumber sizes alone will net the American lumber consumers and the lumber trade a saving of $250,000,000 a year.

Survey of Agricultural Engineering Progress

A review of current literature on engineering as applied to agriculture prepared monthly by Robert W. Trullinger, Mem. A. S. A. E., specialist in rural engineering, Office of Experiment Stations, U. S. Department of Agriculture

Performance of a Warm Air Furnace with Anthracite and Bituminous Coal, A. P. Kratz. (Jour. Amer. Soc. Heating and Ventilating Engin., Easton, Pa., 30 (1924), No. 5, pp. 383-389, figs. 5.) Studies conducted at the University of Illinois to compare the performances of a cast-iron circular radiator type of warm-air furnace operating with anthracite and bituminous coal and to determine the effect of the use of a slotted fire pot on the operation with bituminous coal are reported.

Within practical combustion rates the anthracite coal gave higher efficiency and capacity, as indicated by the rise in the temperature of the air from inlet to bonnet, than the bituminous coal for the same combustion rate. However, the reverse was true at combustion rates that were excessive for warm-air furnace practice. The efficiency of bituminous coal was more nearly constant over the whole range of combustion rates than was that of the anthracite coal. More draft was required between the ash pit and smoke outlet to operate the furnace on anthracite coal than on bituminous coal at a given combustion rate. The slotted fire pot gave about 9 per cent greater efficiency and capacity with bituminous coal than the fire pot with slots sealed.

The fire pot temperatures increased with an increase in combustion rate for the anthracite coal, while the reverse was true for the bituminous coal. This is taken to indicate that the higher drafts required to produce the higher combustion rates cause an increase in the amount of air drawn through the slots and result in cooling the fire pot. The temperature of the fire pot was uniformly lower for the bituminous coal than for the anthracite coal. The fire pot temperature was also materially lower for the slotted fire pot than for the one with the slots sealed. More combustion took place above the bituminous coal fuel bed than above the anthracite bed. On the other hand the radiator temperatures seemed to indicate that the combustion in the case of the bituminous coal was more retarded in the radiator, and that probably the loss due to the combustible in the flue gas was greater than it was for anthracite coal.

In the bituminous coal tests the soot collected on the inner surface of the radiator to a depth of about ⅝ inch at low rates, while at high rates the surface remained practically free from soot.

Curing Conditions of Concrete Drain Tile, D. G. Miller. (Concrete [Detroit], 24, (1924), No. 6, pp. 235-238, figs 11.) Experiments conducted by the U. S. D. A. Bureau of Public Roads in cooperation with the University of Minnesota and the Minnesota State Department of Drainage and Waters on the best curing conditions for concrete drain tile are reported.

The results indicated that strength of concrete drain tile is a reasonably good indicator of resistance to sulphate waters. Consequently variations in the mix, consistency, and grading of the aggregate which tend to increase the compressive strength also tend to prolong the life of the specimens.

It is noted that cylinders cured longest in water attained the highest strength at 28 days but showed the least resistance to the action of a one per cent solution of sodium sulphate, the resistance being closely proportional to the length of time the cylinders were stored in air. Even when concrete was kept continuously wet for as long as twelve months and then stored without drying in sulphate solutions the increase in resistance as compared with specimens cured in water for twenty days was slight.

The results to date are taken to indicate that for water-cured concrete for exposure to the action of sulphates two distinct phases of the curing period should be given consideration. The first of these is the length of time the concrete is kept moist, and the second is the treatment following the curing period proper. Regardless of the length of time cured under moist conditions concrete must be allowed subsequently to thoroughly dry and harden in the air if great resistance to attack by sulphates is to be expected.

Steam-cured concrete has been found to make by far the best showing in the tests. It is concluded that, if properly done, little or no strength need be sacrificed in order to steam cure concrete drain tile at a temperature nearer the boiling point of water if work now under way proves conclusively that the value of such treatment for developing resistance to sulphate waters is as great as indicated.

The Capillary Distribution of Moisture in Soil Columns of Small Cross Section, W. W. McLaughlin. (U. S. Dept. Agr. Bul. 1221 (1924), pp. 23, figs. 7.) Studies conducted at intervals over a period of six years on the distribution of moisture in soil columns of small cross section are reported. Previous studies dealt with comparatively large columns (E. S. R., 43, p. 722).

It was found that the moisture was not distributed at a uniformly decreasing rate with height above the water table. The maximum percentage of moisture occurred at an appreciable distance above the water table varying from one-seventh to one-fourth the height of the moist part of the column. In some cases the second fourth of the column from the bottom contained as much or nearly as much as the bottom fourth.

In all tests extending over a period of ten days or longer, except those with Idaho sandy soil, the lower half of the tube contained more moisture at all points than the average amount contained throughout the column. The average percentage of moisture occurred at points varying from the middle to two-thirds the height of the column. There was a considerable length a few inches above the water in all columns containing approximately the same percentage of moisture. Various methods of packing the soil columns and the facility with which air may escape from or enter into the soil column did not appear to alter the general plan of moisture distribution. Ventilated soil columns had a slightly more uniform varying moisture content with height above water than did the columns not ventilated.

Experiments with horizontal soil columns of small area and having a vertical rise of 4 inches before a change to horizontal showed that the maximum percentage of moisture occurred close to but not necessarily at the end of the tube nearest the water. The average percentage of moisture in the tube was found at a distance from the water equal to more than half the length of the tube. The distribution of moisture was altered when the moisture reached the outer end of the tube.

In tubes inclined downward from the horizontal the greatest percentage of moisture was found at the top of the tube when gravity and capillarity were both acting. The total quantity of water which could be retained by the soil column by capillarity in the absence of ground water was much less than capillary saturation. These results are taken to indicate that if the downward movement of capillary moisture be checked by an impervious stratum, the distribution of moisture above this stratum will in time be similar to the distribution of moisture in a vertical column extending upward from this stratum and with a water table at the stratum.

On the Velocity of Flow in Sewers Partly Full, M. T. M. Ormsby. (Surveyor and Municipal and County Engineering, London 65 (1924), No. 1679, pp. 297, 298, fig. 1.) Tabular and graphic data on the velocity of flow in sewers partly full are presented and discussed mathematically.

Tests of Loss of Head in Standard Elbows and Tees, L. Perry. (Engineering News-Record, New York 92 (1924), No. 22, p. 940, fig. 1.) Experiments conducted at Lafayette College showed that the losses of head through standard 1, 1.5, and 3-inch wrought iron elbows were $0.016v^2$, $0.014v^2$, $0.011v^2$, and $0.01v^2$, respectively, in which v is the velocity of flow in feet per second. In the formula $H=k\ v^2/2g$, in which H is loss of head, it was found that the constant k had respective values for the four sizes of elbow of 1.04, 0.91, 0.71, and 0.64.

Similar investigations with four standard 1, 1.5, 2.5, and 3 inch tees showed that losses of head were $0.0084v^2$, $0.005v^2$, $0.0031v^2$, and $0.0025v^2$, respectively, and the values of k, 0.54, 0.32, 0.2, and 0.16 respectively.

Effect of Alkali on Strength of Mortar, C. E. Proudley. (Engineering and Contracting, Roads and Streets, Chicago 61 (1924), No. 6, pp. 1205-1206, figs. 2.) The progress results of experiments conducted by the U. S. D. A. Bureau of Public Roads to determine to what extent the presence of alkali in mixing water is harmful to cement mortar are reported.

These show that the presence of alkaline sulphates in the mixing water in quantities of less than 1.5 per cent has no serious effect on the strength or other physical properties of Portland cement mortar. One per cent alkaline solutions in contact with cement mortar in mixes of 1:2 and leaner cause a progressive decrease in the strength of the mortar. The decrease in strength of mortar subjected to alkali action may be somewhat accelerated by the presence of considerable quantities of alkali in the mixing water, and for this reason the use of pure water in mixing is considered advisable under such conditions.

Tests on Holding Power of Lead Joints in Water Pipe Plugs, J. H. Quense. (Engineering News-Record, New York 92 (1924), No. 20, pp. 867, 868, figs. 3.) Tests to determine how much holding power the lead alone offers to prevent the plug from moving in 6, 8, 12, 16, and 20-inch water-pipe joints are briefly summarized.

Discharge Measurements for the Control Section Weir, J. L. Savage. (Engineering News-Record, New York 92 (1924), No. 20, p. 842, figs. 3.) Data from experiments conducted by the U. S. Department of Interior, Bureau of Reclamation, on a new type of measuring structure known as the control section weir are briefly presented and discussed.

It is shown that the control section weir is superior to the sharp crested weir or to the Venturi flume in several respects. It requires less fall than the sharp crested weir and can be so constructed that no pool is required above. As compared with the Venturi flume it has the advantage of requiring only one reading, which may be taken in the smooth water above the control notch upon an ordinary weir gauge. Furthermore, the observed head, which is the total depth over the bottom of the control notch, is much greater than the difference in head observed for a Venturi flume and is therefore less affected by small errors in observation.

Air Leakage Around Window Openings, C. C. Schrader. (Journal of American Society for Heating and Ventilating Engineers, New York 30 (1924), No. 6, pp. 465-474, figs. 8.) In a second contribution to the subject (E. S. R., 51, p) studies are reported on the effect of increasing the crack and clearance of windows on the leakage. A double-hung wooden sash 2 feet 8 inches by 5 feet 2 inches by 1⅜ inches was used.

The results showed that the size of the crack around the perimeter of the sash has no appreciable effect on the leakage for a plain window. However, the leakage increased rapidly with an increase in clearance. With a weather stripped window and a constant width of crack it was shown that the leakage also increased quite rapidly with an increase in clearance until the clearance equaled the crack, after which the increase in leakage was not so rapid.

The results obtained with the interlocking type of weather stripping were more consistent than those obtained with the rib stripping.

The Hydrogen Ion Concentration of Lime Treated Water and Its Effect on Bacteria of the Colon-Typhoid Group, R. D. Scott and G. M. McClure. (Jour. Amer. Water Works Assoc., Baltimore 11 (1924), No. 3, pp. 598-604.) Studies conducted at the Ohio State University on the relation of the H-ion concentration of treated water to the coli bacteria content are reported.

References are cited which indicate that bacteria of the colon-typhoid group are destroyed in media of low H-ion concentration, the limiting value being in the neighborhood of pH 9.5. The results of examinations of samples from water purification plants indicated that this limiting pH value applies also to water. The point is raised that processes involving lime treatment in the course of which the water attains a low pH value may possess an advantage over others in bacterial efficiency.

Rectification of Diluted Crankcase Oil, R. L. Skinner. (Jour. Soc. Automotive Engin., New York 15 (1924), No. 1, pp. 51-59, figs. 9.) The engineering development of a rectifying device and system designed to combat the problem of diluted crankcase oil is briefly outlined.

In this system diluted oil is drawn from the cylinder walls and pistons by vacuum and conducted into a still where it is subjected to heat from the engine exhaust. The heating action is just sufficient to volatilize the fuel and water, the resulting vapor being returned to the intake manifold and thence to the engine where it is burned. The lubricating oil that remains behind is conducted back into the crankcase.

Comparative tests to determine engine wear with and without the device are described. In one of these dust was intentionally introduced into the intake manifold. It was found that an ordinary amount of dust is not harmful if the oil is maintained at somewhere near its initial viscosity by a rectifying device. Data on relative wear are presented graphically.

Testing of Air Cleaners, A. B. Squyer. Jour. Soc. Automotive Engin., New York 15 (1924), No. 1, pp. 33-37, figs. 5.) Studies of methods of testing air cleaners are reported.

It is stated that the three essential requirements of air cleaners are maximum cleaning efficiency, minimum attention from the operator, and minimum power loss. Among other methods of testing, an attempt was made to use a dry centrifugal cleaner of predetermined efficiency in series with the cleaner under test to catch a portion of the dust escaping. It was found, however, that the efficiency of the centrifugal cleaner varied with the fineness of the dust and that the dust escaping another cleaner was so fine that almost none of it was caught by the centrifugal cleaner.

It was discovered that soft felt ⅜ inch or more thick was 100 per cent efficient when used as a filter. A filter was therefore arranged using soft felt ⅝ inch thick interposed in the air line from the cleaner under test to the carburetor. The filter was arranged so that the felt could be removed and weighed. In making a test the apparatus was set up using an air jet for suction instead of an engine. A venturi meter was inserted in the line to assure correct air velocity. The apparatus was operated without feeding dust until the weight of the felt became constant. Then 50 grams of dust was fed into the cleaner and from the increase in weight of the felt filter the efficiency of the cleaner was computed. The best cleaners, as determined by this method, were then checked by the use of an engine under load on a Sprague cradle dynamometer.

Transmission of Power by Means of Pulleys, Belts and Shafts, N. D. Steve and F. H. Behrends. New York Agricultural College (Cornell) Extension Bulletin 72 (1923), pp. 42, figs. 49.) A large amount of practical information on the subject is presented.

A Roller for Use on Peat Land, J. T. Stewart. (Journal American Peat Society, Toledo 17 (1924), No. 2, pp. 57-69, figs. 9.) Information, drawings, and a bill of material for the construction of a roller for use on peat land are presented. Experiments with different rollers are also briefly reported which were conducted at the Minnesota Experiment Station. These showed that a roller for use on peat land should weigh from 700 to 800 pounds per lineal foot. A roller 30 inches in diameter has proved satisfactory, and a rolling length of 42 inches is satisfactory for use by either team or small tractor. Two short rolls are preferable to one long roll. A shell made of 0.25 inch boiler plate steel with welded seam has been found satisfactory from the standpoint of service. The shaft should be loose and not fixed in the roll, and the roll should be filled with a dense concrete. The frame may be made of wood, steel, or a combination thereof.

Impact Tests on Concrete Pavement Slabs, L. W. Teller. (U. S. Dept. Agr., Public Roads, 5 (1924), No. 2, pp. 1-14, figs. 24.) In a continuation of studies on the magnitude and effect of motor truck impact begun four years ago (E. S. R., 46, pp. 285, 489), the results of tests of a second series of slabs more comprehensive in its range of types are reported. Specimens 7 feet square laid on a moderately plastic clay subgrade were used, the wet portion having water standing almost level with the surface and the dry portion being merely damp with capillary moisture. Repeated impacts increasing to the maximum which caused cracking were applied at the corner and at the center of one edge by an impact machine dealing blows closely resembling the impact of motor trucks.

The resistance of road slabs was found to depend in part upon the supporting value of the subgrade. A subgrade of high supporting value materially increased the resistance to impact. The impact resistance of rigid slabs varied as som power of the depth of the slab less than two. In general, plain concrete slabs showed no more resistance to impact delivered at the edge than at a corner. Transverse and longitudinal cracks near the sides of a road slab could be caused by impact delivered at the edge of the slab. Plain concrete of 1:3:6 mix offered a resistance to impact ranging from about 60 to 80 per cent and that of plain concrete 1:1.5:3 mix. The lean mix also showed more variation in strength.

Reinforcing steel when present in sufficient amount and so placed as to receive tensile stresses added to the resistance of concrete slabs to impact. Reinforcing steel placed longitudinally and transversely in equal percentages was more effective in preventing corner failures than the same amount placed in one direction. For a given percentage of steel small deformed rods closely spaced seemed to be more effective than large deformed rods widely spaced.

There was very little evidence of cushioning by bituminous tops on concrete bases at temperatures of 90 degrees Fahrenheit or less. There was no evidence that bituminous tops on concrete bases add to slab strength of the base, with the possible exception of 4 and 6-inch bases on dry subgrades. None of the unreinforced slabs laid on a wet plastic subgrade was capable of resisting impact at the edge or corner equivalent to that of a 5-ton truck. Only 8-inch 1:1.5:3 slabs and 2-inch Topeka tops on 8-inch 1:1.5:3 bases resisted edge or corner impact equivalent to that of a 3-ton truck. All unreinforced slabs of lesser thickness failed under edge or corner impact less than that of a 2-ton truck. When laid on a dry subgrade the 8-inch plain concrete slabs of 1:1.5:3 mix and the 8-inch edge thickness, unreinforced 1:1.5:3 bases with 2-inch Topeka tops resisted edge and corner impact equivalent to that of a 5-ton truck with a safe margin. No other slabs were capable of resisting the 5-ton truck impact even under the favorable conditions of dry subgrade support. A section of 6-inch plain concrete base of 1:1.5:3 mix with a 2-inch Topeka top resisted the edge impact of a 3-ton truck. No other slabs of lesser thickness laid on the dry subgrade were capable of resisting impact greater than that of a 2-ton truck.

None of the systems of steel reinforcing testing added sufficiently to the strength of a 6-inch 1:1.5:3 concrete slab to enable it to resist the edge and corner impact of a 3-ton truck when the slab was supported by a very wet plastic subgrade nor to resist the impact of a 5-ton truck when the slab was supported by a dry subgrade. In some of the tests there was evidence that while the presence of the steel did not assist gratly in preventing the formation of the first crack, it did prevent the development of the crack and the further failure of the slab.

Does Paint Preserve Wood? H. D. Tiemann. (Scientific American, New York 130 (1924), No. 5, pp. 314, 315, figs. 6.) Data are reported from studies conducted at the U. S. D. A. Forest Products Laboratory which showed that paint is not proof against gradual absorption of moisture and therefore it will not prevent the occurrence of swelling or shrinkage in wood. It is shown, however, that paint does retard the rate of absorption or loss of moisture through the surface of wood, thus giving time for a partial equalization of the moisture and reduction of the moisture gradient within the wood.

It is further shown that paint does not make wood poisonous to wood-destroying fungi, but by preventing the surface cracks it makes it more difficult for the fungi to get a foothold and thus helps to preserve the wood. The equalization of the moisture distribution throughout a piece of wood brought about by a coating of paint when applied to all surfaces also prevents excessive warping of the piece as a whole.

Further Studies of Discharge Through Adjustable Submerged Orifices, H. A. Wadsworth. (Engineering News-Record, New York 92 (1924), No. 20, pp. 866, 867, figs. 3.) In a contribution from the University of California the results of 107 observations made on a new submerged orifice at the hydraulic laboratory at Fort Collins, Colo., are summarized. The openings ranged in size from 0.25 to 2.25 square feet.

A. S. A. E. and Related Engineering Activities

Winter Meeting of Farm Power and Machinery Division

THE Council of the American Society of Agricultural Engineers several months ago approved the holding of a special meeting of the Farm Power and Machinery Division of the Society. The project was definitely gotten under way at the annual meeting of the Society held at Lincoln, Nebraska, in June and a meeting of the Division has now been definitely planned for the early part of December of this year. The meeting will be held in Chicago and will be devoted exclusively to problems confronting agricultural engineers associated with the farm equipment industry.

A tentative program has been prepared and plans are well under way and give promise that the meeting will be of unusual interest and value to all who are concerned with the engineering phases of the farm-equipment industry. Definite date of the meeting will be announced later. Suggestions regarding the meeting will be welcome to those in charge of the program, and should be sent either to F. A. Wirt, chairman of the Farm Power and Machinery Division, or to the Secretary of the Society.

1925 Annual Meeting

THE place for holding the 1925 annual meeting of the Society has been definitely settled upon by the Council of the American Society of Agricultural Engineers; the decision, which was unanimous, favored Madison, Wisconsin, as the place for the 1925 annual meeting, with the definite recommendation that the 1926 meetng be held somewhere in California. The Council has not yet decided upon definite dates for the meeting, which will probably be deferred until early in 1925. The chairman of the Meetings Committee, however, has been appointed and preparations for the meeting will be gotten under way at once.

Zimmerman to Fill Vacancy

THE Council of the American Society of Agricultural Engineers recently appointed Major O. B. Zimmerman, experimental engineer of the International Harvester Company, to the office of first vice-president made vacant when H. B. Walker, of Kansas State Agricultural College, assumed the office of president on the passing away of Prof. F. W. Ives.

Major Zimmerman is one of the outstanding engineers in the farm-equipment industry. He has presented some exceptionally valuable papers before meetings of the Society and has been active in committee work. He is at present chairman of the Standards Committee of the Society.

Protest Against Wooden Sleeping Cars

THE fatalities resulting from the railroad accident which occurred near Chirago last June, whilh resulted in serious and fatal injuries to a number of prominent engineers of the country, were confined practically entirely to the occupants of a wooden Pullman sleeping car placed between two steel sleepers. It was from injuries received in this accident that resulted in the passing away of F. W. Ives, just elected president of the American Society of Agricultural Engineers, and J. H. Dunlap, secretary of the American Society of Civil Engineers.

It seems that it is quite a common practice for the railroads to place wooden sleepers between steel ones, especially when traffic is so heavy that they cannot handle it with the usual number of sleepers. The fact that the wooden sleeper was less resistant than the two steel ones on either side naturally resulted in its being badly demolished, with obviously more fatal results to the occupants.

Because of the loss which this Society has sustained as a result of the accident mentioned and which probably would not have resulted fatally to Prof. Ives had the sleeper he occupied been of steel construction, and also because in its opinion the practice of sandwiching wooden sleepers between steel ones is to be deplored, the Council of the American Society of Agricultural Engineers has passed the following resolution as a protest against the continuance of this practice:

"WHEREAS, in the passing away, on July 5, 1924, of Frederick Walter Ives, president of the American Society of Agricultural Engineers, as the result of injuries received in a railroad accident near Chicago on June 30, in which several other prominent engineers also lost their lives or were seriously injured, the membership of the Society is conscious of an irreparable loss in the untimely and unnecessary passing of our beloved friend, co-worker, and president, and also of the loss to the engineering fraternity and the public at large of all the engineers who were fatally injured in said accident, and

"WHEREAS, the fatalities were confined largely to the occupants of a wooden Pullman sleeping car placed between two steel sleepers, which naturally resulted in the more complete demolishing of the wooden car and more serious injury to those occupying it, therefore, be it

"RESOLVED that the Council of the Society enter a vigorous protest against further use by the railroads of wooden sleeping cars, except possibly in trains which are made up of all wooden sleepers, but under no conditions in trains where single wooden sleepers are placed between steel cars, and be it further

"RESOLVED that this protest be laid before American Engineering Council with the recommendation that that body as the federation of leading organizations of engineers of the country, formally protest, on behalf of engineers of all classes, to the Interstate Commerce Commission against the further use of wooden Pullman sleeping cars between steel sleepers, and, further, that the complete abandonment of the use of wooden sleepers as early as feasible be strongly urged."

A. E. S. C. Report Shows Progress in Standardization

THERE now exists the most wide-spread interest and activity in industrial standardization that has ever been shown, according to the new yearbook of the American Engineering Standards Committee.

The work of the Committeé is indicative of the growth of the movement as a whole. One hundred and fifty two projects have been completed, or are under way, and in these various projects two hundred and thirty-five national organizations—technical, industrial, governmental—are officially cooperating through accredited representatives. The number of the individuals serving under various sectional committees of the different projects is nearly eleven hundred.

Of the projects which have reached an official status, 31 have to do with civil engineering and the building trades; 25 with mechanical engineering; 15 with electrical engineering; 4 with automotive subjects; 11 with transport; one with ships and their machinery; 14 with ferrous metals; 15 with non-ferrous metals; 12 with chemical subjects; 2 with textiles; 5 with mining; 5 with the wood industry; 1 with the paper and pulp industry; and 11 projects with topics of a miscellaneous or general character.

Cooperation in joint activities between the Division of Simplified Practice of the U. S. Department of Commerce and the American Engineering Standards Committee has steadily increased. In general the work of the Committee is concentrated upon standardization projects which involve technical considerations, while the Division of Simplified Practice concentrates upon such eliminations as it is possible to carry out from a consideration of statistical production data alone.

In order to meet the demands made upon it by industry, and to supply the needs of the various working technical standardization committees, the American Engineering Standards Committee has greatly broadened its information services, and has added an Engineer Translator to its staff for this purpose. In this way, complete information is made available to sustaining members, trade and technical associations and other inquirers on standardization activities in foreign countries, as well as in the United States.

A new development is the appointment of local representatives of the Committee in four important industrial centers.

One of the most striking developments of the standardization movement is the increasingly important role which trade associations are playing in it. More than 140 national trade associations are officially participating in standardization projects under the auspices of the American Engineering Standards Committee.

More and more trade associations, no matter for what purpose they may have originally been organized are going into technical work, and it is natural if not inevitable, that both trade and technical associations should eventually concern themselves to an increasing extent with standardization activities. This tendency is becoming more marked on every hand.

The A. E. S. C. yearbook may be secured by addressing the American Engineering Standards Committee, 29 West 39th Street, New York City.

New A. S. A. E. Members

George C. Kreutzer, director of farm economics, Bureau of Reclamation, Department of Interior, Wilda Building, Denver, Colorado.

E. Grant Lantz, Omaha National Bank, Omaha Nebraska.

TRANSFER OF GRADE

Richard C. Miller, assistant professor of agricultural engineering, North Dakota Agricultural College, Fargo, North Dakota. (From Junior Member to Member.)

Applicants for Membership

The following is a list of applicants for membership received since the publication of the August issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send pertinent information relative to applicants for the consideration of the Council prior to election.

Edward Barr, executive director, Northwest Dairy Exposition Committee, 884 Linwood Place, St. Paul, Minnesota.

G. Santos Y. Ciocon, in charge of agricultural engineering investigations, Bureau of Agriculture, Manilla, Philippine Islands.

Stanley W. Crosby, research associate in soil technology, University of California, 86 Eucalyptus Road, Berkeley, California.

Horace M. Davis, director Nebraska Committee on Public Utility Information, 360 Fraternity Building, Lincoln, Nebraska.

Dudley F. Holman, construction engineer, National Lumber Manufacturers Association, Transportation Building, Washington, D. C.

Ching Po Sun, department of agricultural engineering, University Farm, St. Paul, Minnesota.

TRANSFER OF GRADE

James Arthur Muncey, 326 West 23rd Street, Houston, Texas. (From Student to Junior Member.)

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Medford, Long Island, New York

A. S. A. E. Employment Service

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of Agricultural Engineering. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Nonmembers as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

AGRICULTURAL ENGINEER, 1923 graduate of Kansas State Agricultural College in agricultural engineering, desires to make a change. Work along engineering lines is preferred. Address M. S. Cook, 5406 Ferdinand Street, Chicago, Illinois. MA-121.

AGRICULTURAL ENGINEER with experience on large farms with all kinds of machinery and equipment wants position with manufacturer of farm equipment. MA-122.

AGRICULTURAL ENGINEER wants position with contractors doing work in farmstead planning and building. MA-123.

AGRICULTURAL ENGINEER open for position as sales engineer, salesman, advertising writer, or agricultural propagandist. Past experience with large agricultural firms. MA-124.

Positions Open

AGRICULTURAL ENGINEER to handle farm machinery, farm power, and related lines of work needed to fill vacancy in the department of agricultural engineering at the University of Idaho, Moscow. Man selected will have the major portion of his time taken up with teaching but will have some time and opportunities for research work. Address E. J. Iddings, dean and director, College of Agriculture.